CS-308-2014 Final Report

Wall-E

Order of Phoenix

TH-5

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1. Introduction

Our project is a waste product classifier and separator. Due to industrialization, the amount of waste produced is increasing very rapidly. There are many waste products which can be collected and recycled which helps to reduce degrading effects on environment. In order to recycle, first the waste products have to be segregated and those which can be recycled should be identified and separated from the rest. Doing this manually consumes a lot of human labour and also working in such an environment can have harmful effects on the workers. We can avoid this if the process is automated by machines.

Our aim is to build a system which automatically classifies the type of the waste product and puts it in the container assigned to that specific type.

2. Problem Statement

Our initial aim was to classify waste products. But due to time constraints, we had to focus on building the mechanical part of our system and reduced our problem to classifying different shapes. Our problem statement can be described as follows:

1. A conveyor belt exists, on which an object is initially placed at the beginning (We are not dealing with object separation problem here).
2. At about half way of the conveyor belt, a camera is held from the top which captures the images of object and sends them to the computer for image processing.
3. The computer classifies the image and sends the information to the Firebird robot.
4. Firebird robot has mechanical arms attached to it. Depending on the class of the object, the robot uses the corresponding arm to push the object into its respective container.

We are assuming that the user wants to classify objects which have already been separated from one another and put them into different containers according to the category.

3. Requirements

3.1 Functional Requirements

1. Identify and classify the objects correctly.
2. To be able to place the object in its corresponding container.
3. The classification and separation should be in real time so that there is no interference between classification of one object and that of the successive object.

3.2 Non-Functional Requirements

1. The pushing of the object into the container should not take more than 6 seconds.
2. Classification of the product should be complete within 1 second.

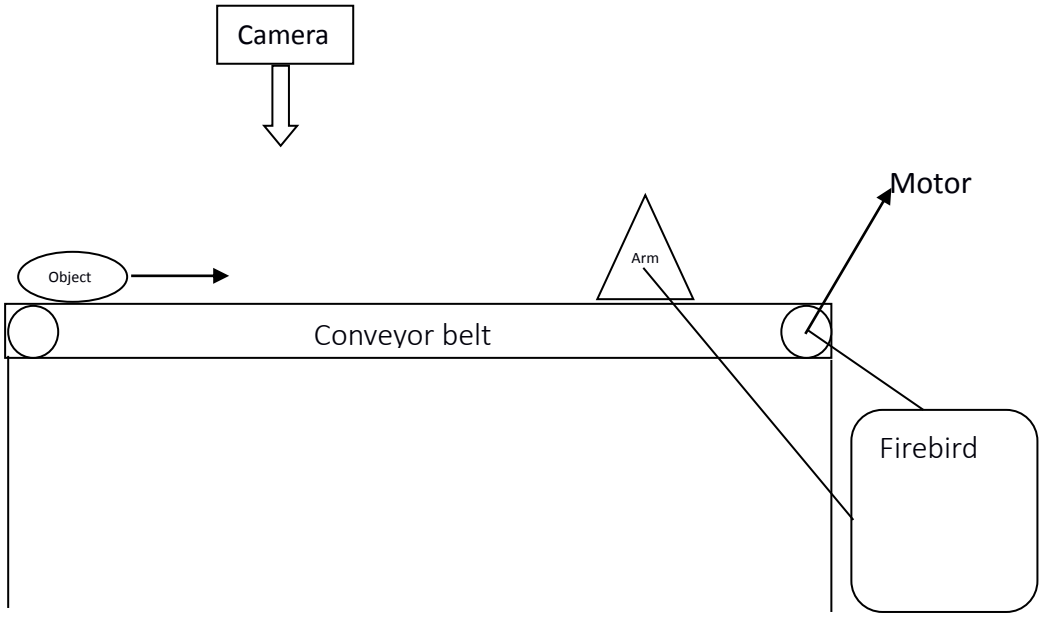
3.3 Hardware Requirements

1. Firebird
2. Belt with teeth and corresponding wheels for conveyor belt mechanism.
3. 2 DC motors: 1 for rotating conveyor belt, 1 for mechanical arm
4. Camera
5. Xbee for wireless transmission

3.4 Software Requirements

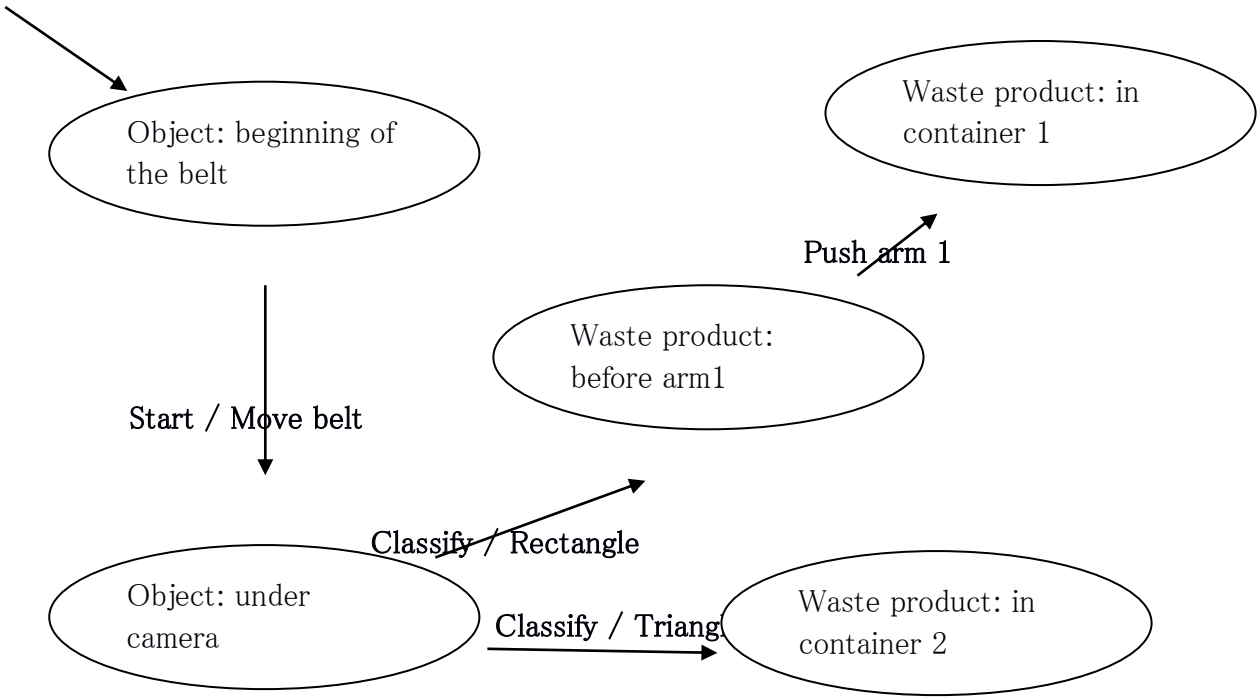
1. Python
2. SimpleCV for Python for image processing.
3. Keil for programming Firebird.

4. System Design

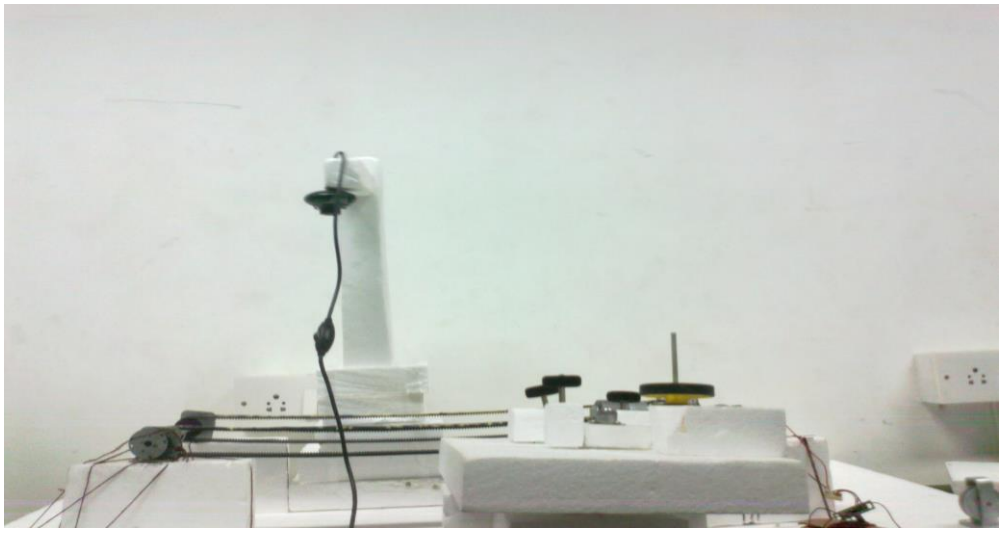


The above given is a block diagram showing the architecture of our system.

Finite State Machine of our system:



The system is mounted on a thermocol base.

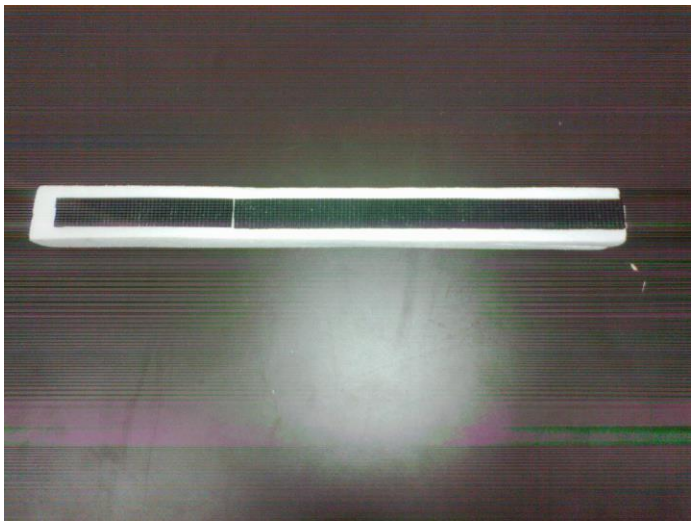


The conveyor belt is constructed using a rubber belt with grooves or teeth on one side. Two belts are used, one as each side of the conveyor belt. Each belt goes around wheels on two ends.

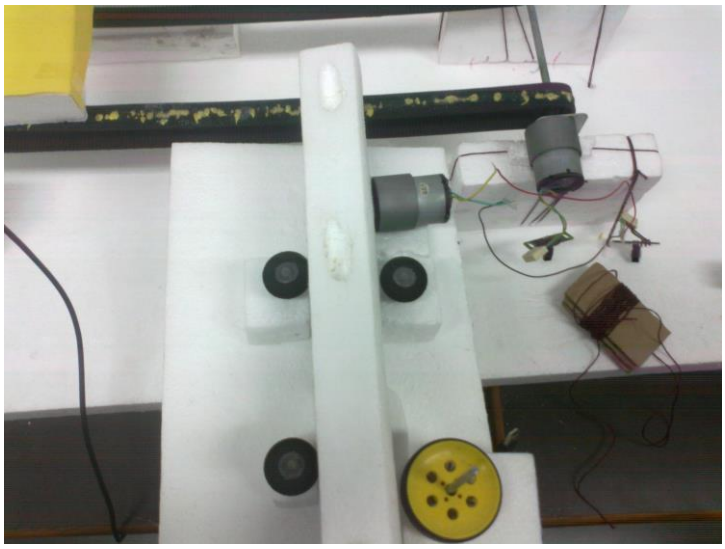
Opposite wheels on one end are connected by an axle. One wheel on one end is connected to the DC motor which is connected to the Firebird. All the four corners of the conveyor belt are mounted

on thermocol pieces of equal height.

The mechanical arm is a long thermocol rectangular cylinder and a rubber belt is stuck on one end which acts as the bottom face of the arm. The arm is placed on a wheel attached to another DC motor. For support a small roller wheel is placed on other end.

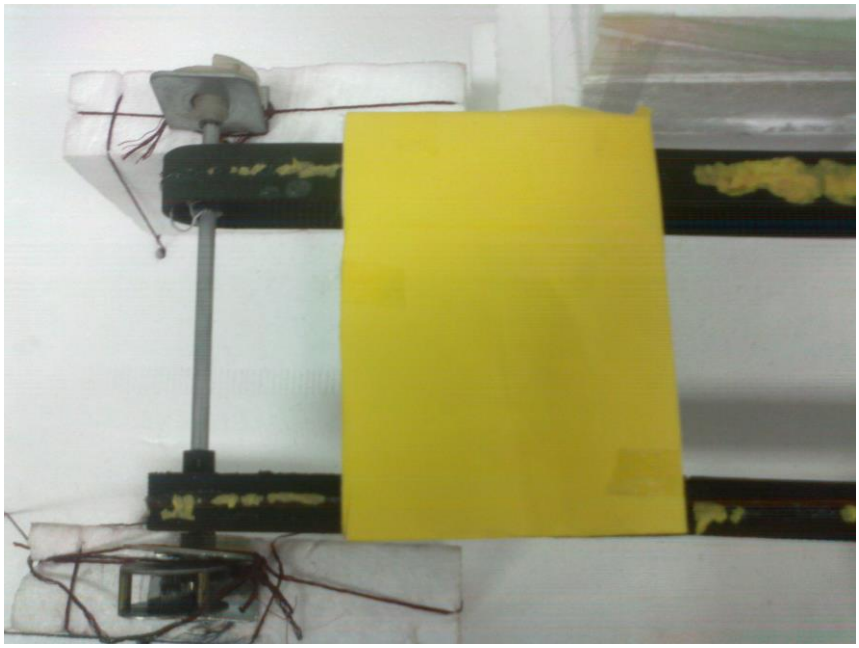


For support on either sides of the arm wheels are placed, which rotate when the arm moves front and back.



5. Working of the System and Test results

First the c program is loaded into the Firebird. The image processing code in python is run which takes pictures from the camera at regular small intervals to detect an object. Then the Firebird is turned on which starts the conveyor belt. An object is placed on the left end of the conveyor belt like this:



When it passes under the camera, the python detects that an object has passed and runs a KNN classification algorithm. If it is a rectangular shape, it passes a wireless signal to Firebird using Xbee to stop the conveyor belt and push the arm when the object comes in front of the arm. The conveyor belt is started when the arm comes back. If it is triangular shape, no such instructions are passed and the belt is not interrupted.

Testing:

1. Identify and classify the waste products correctly.
    - We placed the objects in front of the camera and noted down the class shown on the screen. It showed correct class 8 out of 10 times. This of course depends on the training data.
2. To be able to place the product in its corresponding container.
    - Here we have to basically test whether the arm is able to push the object out of the conveyor belt. This depends on the arm construction. Our arm was able to correctly push the object 6 out of 10 times.
3. The classification and separation should be in real time so that there is no interference between classification of one product and that of the successive product.
    - There was no interruption in the classification and separation of consecutive objects in all the times we have done.

6. Discussion of System

a) What all components of your project worked as per plan?

1. The conveyor belt, except we were not able to join the two belts with a paper or cloth because there was a very minute difference in the lengths of the belts. So eventually, two points on the opposite belts starting at the same position gradually moved away from each other resulting in the stretching of the paper or whatever material we are using to join the belts. So we had to not join the belts and require that the objects' width should be such that it fit on the belts.
2. The mechanical arm worked as expected but we could have made it more rigid and firm.
3. The classification worked as expected.

b) Changes made in plan from SRS:

1. We said that we would classify the waste products. But we have reduced the problem to classify shapes. We did this because the conveyor belt construction took too long and the time was not sufficient to focus on the classification part.
2. We said we would classify three classes but we did two classes due to insufficient length of the belt we could obtain for the conveyor belt. It was not sufficient to place two arms. Any ways it is easy to add another arm if the conveyor belt is a bit larger than what we have made.

7. Future Work

Short Term:

1. We can place an additional arm for classification of another class.

2. The classification should be made for actual waste products.

Medium term:

1. For metallic waste, we can place a magnetic material at the starting of the belt so that it attracts them and pulls into their container.
2. Instead of thermocol, we can use more rigid substances like wood, aluminium etc. But it takes much more accuracy to decide upon the lengths.

Long term:

1. We can focus on the object separation problem, i.e. separating waste products dumped in a heap.

Everything we used in this system has the ability to be reused in one way or the other in future extensions.

8. Conclusions

This project has a large scope and though we could only accomplish initial stages of it, if we can do everything mentioned in the future work using as little money as possible, it could be of great help.

We would like to thank Prof. Kavi Arya for giving us this opportunity to build a mechanical system. Being in Computer Science department, we never got an opportunity to do such a project in the previous years. Doing this project has definitely broadened our horizons.